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RESEARCH MEMORANDUM

PROJECTED COSTS FOR THE TANKER PORTION OF THE READY RESERVE FORCE

Ronald F. Rost

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1. Enclosure (1) is forwarded as a matter of possible interest.

2. This research memorandum provides estimates of the costs of the tanker portion of the Ready Reserve Force from 1987 to 1995. These estimates show what it would cost if the Navy chose to fill the entire shortfall of U.S.-owned militarily useful tankers by building up the RRF. Without additional funding of about $200 million or more per year over the next nine years, the tanker RRF probably would not be able to accomplish the Navy's fuel delivery mission.

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CRM 87-17 / February 1987

PROJECTED COSTS FOR THE TANKER PORTION OF THE READY RESERVE FORCE

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ABSTRACT

This research memorandum provides estimates of the costs of the tanker portion of the Ready Reserve Force (RRF) from 1987 to 1995. These estimates show what it would cost if the Navy chose to fill the entire shortfall of U.S.-owned militarily useful tankers by building up the RRF. The study does not recommend this course of action, but merely establishes what the Navy's dollar costs are likely to be in the years ahead. An important finding is that the annual costs of an RRF of that size would substantially exceed budgeted funds as reflected in the latest Five-Year Defense Plan. Without additional funding of about $200 million or more per year over the next nine years, the tanker RRF probably would not be able to accomplish the Navy's fuel-delivery mission. Even with such an infusion of funds the RRF may not be workable, because adequate supplies of U.S. merchant sailors and U.S. shipyards may not be available.

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OVERVIEW AND SUMMARY

In an earlier stage of the CNA study of strategic sealift, it was found that unless current maritime policies are changed, the U.S.-flag commercial tanker fleet is likely to continue its rapid decline. By 1990, the U.S.-owned tanker fleet is projected to be substantially smaller than the size required to provide logistical support for U.S. forces during wartime. Moreover, the shortfall is likely to be even larger by the mid-1990s.

The maintenance of adequate strategic sealift capacity is one of the primary goals of the U.S. Navy. Current plans call for the Navy to offset the declines in both tanker and dry-cargo shipping capacity by purchasing vessels that would otherwise be scrapped and keeping them in a high degree of readiness in the Ready Reserve Force (RRF). Because the outlook for the U.S.- flag tanker fleet is decidedly more bleak than it was a few years ago, it appears that the RRF will be much more costly than the Navy had anticipated. An earlier CNA report [1] estimated that the tanker portion of the RRF would have to be about triple the size currently planned. At present, the target level for the tanker RRF in 1990 is 46 handy-sized tankers. Since that target was set, the outlook for domestic crude oil production has worsened and a new major pipeline from California to the Gulf Coast is under construction. The result will be less oil moving by water and the early retirement of many additional U.S.-flag commercial tankers. As an offset, the tanker RRF would have to be expanded to about 104 handy-sized ships by 1990, and to 129 by 1995 (see table 1).

The projections of tanker capacity in the U.S.-owned commercial fleet and in the RRF were developed in [1] and are expressed as thousands of deadweight tons (DWT) and also as handy-sized tanker equivalents (HSTE). An HSTE is a tanker of 200,000-barrel capacity, or roughly 27,500 DWT. Projecting the RRF tanker fleet in HSTEs does not imply that all RRF tankers must be 27,500 DWT. Many of the tankers actually procured for the RRF are likely to be larger – between about 30,000 DWT and 70,000 DWT. To the extent that they are, the number of tankers in the RRF would be smaller than the projected HSTE.

In this memorandum, the tonnage projections for 1995 are converted into existing tankers of various sizes. The process begins with the actual U.S.- flag tanker fleet in July 1986. Each existing tanker is assigned either to a trade route where it is most likely to remain competitive or to the list of retirees – ships that are projected to drop out of the fleet over the next 9 years. In this way, a snapshot of the types of tankers that are likely to be operating under the U.S.-flag in the mid-1990s is developed. The snapshot includes such important characteristics as age, deadweight tonnage capacity, type of propulsion system, and type of tank coating (if any).

TABLE 1

PROJECTED SIZE OF THE RRF
(militarily useful tankers)

	Thousands of deadweight tons	
	1990	1995
Required fleet for military support	7,416	7,416
Projected U.S.-owned commercial fleet	4,554	3,864
RRF fleet	2,862	3,552
RRF fleet in handy-sized tanker equivalents (HSTE)	104	129

Likewise, the snapshot of the retiree list is a detailed breakout of the U.S.-flag candidates for the tanker RRF. The important finding from these tanker lists is that almost all of the U.S.-flag tankers that are likely to drop out of the active fleet over the next 9 years will be at least 20 years old. They may be purchased for not much more than scrap value, but sizable expenditures would have to be made to bring them up to RRF standards.

The purpose of this memorandum is to provide projections of the yearly costs of the tanker RRF through 1995. The above finding is relevant, because it suggests that there probably will not be any bargains on the market. Twenty-year-old tonnage is forecast to sell for very little in the years ahead, but after costs of upgrading are included, the procurement cost for an old tanker is likely to be about the same as for a newer one. The younger militarily useful tankers in the U.S.-flag fleet are expected to remain commercially active into the 1990s and thus are not probable candidates for the RRF. However, foreign flag tankers in the 5- to 15-year-old range are expected to be available on the market and offer an alternative to the purchase of aged U.S.-flag tonnage.

The necessary costs of procuring and maintaining a tanker RRF of appropriate size are estimated and compared to the projected levels of funding for the reserve tanker fleet in the years ahead. Funds already have been appropriated for the RRF for FY 1987 and planned funding levels for FY 1988 through FY 1992 have been developed in the latest five-year defense plan (FYDP). The comparison reveals that the funding needed is far greater than the funding contained in the FYDP. To meet current DOD requirements for logistical support in wartime, about 95 tankers ranging in size from 30,000 to 60,000 DWT are needed by 1995. To keep pace with that requirement, about 70 should be in the RRF in 1992. The conclusion is unavoidable: if the current budget plan comes to pass, the tanker RRF will be too small to do the job.

The cost projections indicate that in FY 1988 through 1992, the tanker RRF would require *additional* funding ranging from $175 to $220 million *per year*. Moreover, because the costs of the tanker RRF projected in this study are only the direct costs—for procurement, maintenance, and activation testing—the funding shortfall might be even larger. A reserve fleet also requires shipyards to repair and maintain it and crews to activate it within 5 to 20 days and to operate it. The demand for merchant sailors and for shipyards depends importantly on the size of the commercial U.S.-flag fleet. If the commercial fleet shrinks too much, the number of merchant sailors and shipyards may become insufficient. Should this happen, the RRF would become ineffective unless new programs were launched to maintain the supply of merchant sailors and shipyards. These potential indirect costs of the RRF were not assessed further in this study, and they remain an unsettled issue among maritime analysts.

U.S.-FLAG CANDIDATES FOR THE RRF

The size and composition of the U.S.-flag tanker fleet in July 1986 are shown in table 2. The existing fleet is composed of 194 ships, including about 25 that are laid up mainly because of a lack of business. Although the capacity of the entire fleet is 13,549,000 DWT, the total tonnage useful for military support is about 6,756,000 DWT, or 149 ships.

Militarily useful tankers are those that are under about 92,000 DWT and have coated tanks. The size limitation is necessary for port and refinery access and for transit through the Panama Canal. Tank coatings, preferably of epoxy, are needed so that tanks can be cleaned well enough to carry jet fuel without unacceptable delays. In table 2, the militarily useful fleet is the sum of product carriers less than 92,000 DWT and the integrated tug/barges (ITBs).

TABLE 2

U.S.-FLAG TANKER FLEET
(July 1986)

	Number	Capacity in thousands of DWT
Crude carriers	33	4,090
Integrated tug/barges	15	604
Product carriers less than 92,000 DWT	134	6,152
Product carriers greater than 92,000 DWT	12	2,703
Total	194	13,549

As indicated above, the U.S.-flag fleet is expected to shrink dramatically by the mid-1990s. Table 3 shows the deadweight tonnage capacity of the fleet in 1995, as projected in [1]. Aggregate capacity is projected to fall from 13,549,000 DWT in 1986 to 5,083,000 in 1995. The bulk of the decline is in the crude oil trades—from Valdez to the West Coast, and from the West Coast to refineries on the Gulf Coast. Alaskan North Slope production is expected to drop, as low oil prices remove the incentive for exploration, drilling, and development. In addition, a major new pipeline—the All American pipeline—will displace tankers on the West Coast-to-Gulf Coast route. The impact will be felt by product tankers as well as crude tankers, because numerous product tankers have been operating in the Alaskan North Slope trades.

TABLE 3

PROJECTED DEMAND FOR U.S.-FLAG TANKERS IN 1995

Trade	Capacity of operating tankers (thousands of DWT)
Alaskan North Slope	2,655
Gulf to East Coast	628
Coastal (East Coast)	174
Coastal (West Coast)	590
International (CDS)	460
Military Sealift Command	576
Total	5,083

In order to convert the projected tanker tonnage in table 3 into a projection of actual "surviving" tankers, the current fleet was allocated among the trade routes. A scheme for allocating tankers to their most profitable routes is shown in table 4. (The scheme was not followed in all cases, because some tankers have carved out profitable niches in trades other than those in which they might be expected to operate.) In general, large tankers have a cost advantage in the Alaskan trades, although a few ships under 100,000 DWT operate effectively on routes such as Valdez to Hawaii. On the other extreme, fairly small product tankers are needed for the coastal trades, the Gulf-to-East Coast carriage of refined products, and Military Sealift Command (MSC) activity. Relatively few tankers are expected to survive in international trade, because they are no longer competitive against foreign-flag ships. The ones that do make it to 1995 probably will do so by picking up MSC charters and other trades reserved for U.S.-flag vessels such as government grain shipments under PL480. Table 4 suggests that tankers in the 40,000 through 99,000 DWT range operate most profitably by hauling crude oil from Panama to the Gulf and East Coasts. Those routes would be ideal, but unfortunately by 1995 Alaskan North Slope and West Coast crude oil production is likely to have decreased enough so that virtually no crude oil will be transiting the canal. Instead, the U.S. will be importing more crude oil and refined products directly into the East and Gulf Coasts, as explained in [1].

TABLE 4

ALLOCATION OF TANKERS TO TRADE ROUTES

	Preferred trade	Second best
Tanker size		
Over 100,000 DWT	North Slope crude	None
70,000 through 99,999 DWT	Chirique Grande to Gulf, East Coast, and Puerto Rico	North Slope crude
40,000 through 69,999 DWT	Chirique Grande and Puerto Armuelles (transiting the Canal) to Gulf and East Coasts; product trade from Gulf to East Coasts	North Slope crude
Under 40,000 DWT	Coastal product trades	None
Barge size		
Over 50,000 barrels	Coastal product trades and Gulf to East Coast product trades	None

Table 5 shows the active U.S.-flag tanker fleet in 1995, categorized by trade route. The specific tankers projected to operate on each trade route are listed in the appendix. In allocating actual tankers against projected tonnage quotas, it is not surprising that the quotas were sometimes violated. Comparing table 5 with table 3, it can be seen that in most cases the tankers assigned to a specific route aggregate to a somewhat larger tonnage. In some cases this was the unavoidable result of working with a discrete distribution of existing tanker capacities. The main reason, however, is that newer and larger tankers have cost advantages on the longer routes, even when they operate less than fully loaded.

The tankers that were in excess of the projected 1995 demand were relegated to the retiree list, which contains those vessels expected to drop out of the fleet over the next 9 years. The projected retirees are summarized in tables 6 and 7, in terms of number of tankers and tonnage capacities. The full list of retirees is provided in the appendix. In tables 6 and 7, retiring integrated tug/barges are included in the count of product carriers under 92,000 DWT. The total tanker capacity projected to be active in 1995—5,979,000 DWT—and capacity projected to retire from 1986 through 1995—7,990,000—exceeds the capacity existing in 1986 shown in table 2—13,549,000—by the tonnage of two Exxon "new builds," the only fleet additions projected over the 9-year horizon.

TABLE 5

THE ACTIVE U.S.-FLAG TANKER FLEET IN 1995

Trade route	Number of tankers[a]	Tanker capacity (thousands of DWT)
Alaskan North Slope (ANS)	19	3,295
Gulf to East Coast	16	728
Coastal (East Coast)	5	196
Coastal (West Coast)	13	622
International (CDS)	8	562
Military Sealift Command (MSC)	19	576
Total	80	5,979

a. See the appendix for the lists of ships expected to survive on each trade route.

TABLE 6

NUMBER OF TANKERS PROJECTED TO RETIRE FROM U.S.-FLAG TANKER FLEET: 1986 THROUGH 1995

Type	Year built		
	1970-79	1943-69	Total
Product carriers:			
Under 92,000 DWT	25	60	85
Over 92,000 DWT	9	0	9
Crude carriers:			
Under 92,000 DWT	2	9	11
Over 92,000 DWT	8	1	9
Total retirees	44	70	114

TABLE 7

TONNAGE CAPACITY PROJECTED TO RETIRE FROM
U.S.-FLAG TANKER FLEET: 1986 THROUGH 1995
(thousands of DWT)

Type	Year built: 1970-79	Year built: 1943-69	Total
Product carriers:			
Under 92,000 DWT	1,381	2,517	3,898
Over 92,000 DWT	1,953	0	1,953
Crude carriers:			
Under 92,000 DWT	129	420	549
Over 92,000 DWT	1,476	114	1,590
Total retirees	4,939	3,051	7,990

It is striking that the ship lists in the appendix contain only two new builds between now and 1995. The reason, of course, is that there is little incentive to build in a declining industry. In general, the expectation is that the newer tankers in the commercial fleet will be the survivors, but by 1995 even ships built in the 1980s will be about halfway through their useful lives. Of the 80 survivors, 22 are likely to be at least 20 years old. However, 12 of these are MSC charters, and the possibility exists that MSC will charter some new builds in place of current long-term or bare-boat charters.

The shortfall of militarily useful tankers in 1995 is derived in table 8. Recall that a shortfall was shown in table 1, in terms of both deadweight tonnage and HSTEs. The shortfall shown in table 8 differs somewhat from the one shown in table 1, because when actual tankers are assigned against the projected tonnage quotas on the trade routes, the tankers aggregate to tonnage capacities that are larger than the quotas, as discussed above.

TABLE 8

SIZING THE RRF TO SATISFY THE TANKER REQUIREMENT
FOR MILITARY SUPPORT
(thousands of DWT)

	Militarily useful tanker capacity
DOD baseline requirement	7,416
Projected U.S.-owned commercial fleet[a]	4,016
Tanker shortfall	3,400

a. Tankers earmarked to be withheld for special military requirements have been subtracted from the commercial fleet. They total 415,000 DWT.

Table 8 shows the DOD estimate of required tanker tonnage to support military operations during wartime as it was developed in the *DOD Sealift Tanker Study* [2]. The baseline requirement is for 7,416,000 DWT of militarily useful tanker capacity. Another 415,000 DWT is needed for special military requirements other than those included in the baseline. The bulk of this latter requirement is for augmentation of the Navy Mobile Logistics Support Force. The capacity of the militarily useful component of the active U.S.-owned tanker fleet in 1995 is projected to be 4,431,000 DWT. This figure is derived from table 5 and the list of active tankers in 1995 shown in the appendix. Specifically, militarily useful tonnage includes three tankers in the Alaskan North Slope trades, with a total capacity of 271,000 DWT, and the total projected tanker tonnage in the other trades. It also includes the projected militarily useful tonnage in the Effective U.S. Control (EUSC) fleet of 1,476,000 DWT. As discussed in [1], DOD expects that ships owned by U.S. citizens or corporations, operating under "flags of convenience," will be made available in wartime.

The tanker shortfall is 3,400,000 DWT. Can it be filled by purchasing militarily useful U.S.-flag tankers as they retire? A glance back at table 7 reveals that the answer is yes. Anticipated retirements of product carriers under 92,000 DWT total 3,898,000 DWT—more than enough.

Whether it would be cost effective to do so is another question. The retiree list in the appendix reveals that only 13 of the 114 U.S.-flag tankers expected to retire will be under 20 years old in 1995, and 7 of those 13 are too large to be militarily useful. Table 6 shows that 60 of the 85 product carriers under 92,000 DWT that are projected to retire were built between 1943 and 1969. The point is that an RRF composed of these vessels would entail sizable costs, incurred in upgrading them so that they could be activated within 5, 10, or 20 days, and could carry fuels—mainly jet fuel—for military support. As will be shown below, foreign tankers are likely to be a better buy.

SECONDHAND TANKER PRICES

A major cost component of the tanker RRF will be the cost of procuring secondhand tankers on U.S. or world markets. Accordingly, it is necessary to project secondhand tanker prices out to 1995. The approach taken here is to obtain projections of secondhand prices for foreign-flag tankers on the world market, and then to infer corresponding prices for secondhand U.S.-flag tonnage. Because the demand for U.S.-flag tankers has been shrinking, few if any secondhand purchases of U.S.-flag tankers have taken place in recent years. Domestic operators already have fleets that are too large, and foreign operators in the market for secondhand tonnage prefer ships with the low-cost diesel propulsion systems that most foreign-flag tankers have. In contrast, U.S. operators' surplus tankers are predominantly steam driven. As a result, excess U.S.-flag tankers find their way to the scrapyard. In the weak tanker market of the 1980s, 10- to 15-year-old foreign-flag tankers with diesel engines have sold for prices close to scrap value. There is no reason to pass them by in favor of a steam-driven power plant that costs much more to operate and not much less to purchase.

Tables 9 and 10 show forecast secondhand prices for 30,000 DWT and 60,000 DWT tankers on the world market over the 1987 through 1995 period. These projections were made by Drewry Shipping Consultants, Ltd., London, and also seem to reflect the consensus of market opinion. The declines projected for secondhand prices through 1990 are a continuation of the weakness in tanker markets that has been prevalent throughout the 1980s. Tanker charter rates and secondhand prices peaked in 1979 and 1980 and have been declining since then. The increases in oil prices from 1974 to 1980 stimulated exploration, drilling, and development of new oil fields, many of which are relatively close to the major oil importers—the U.S. and Northern Europe. Noteworthy examples are those in the North Sea, the Alaskan North Slope, and Mexico. High oil prices also encouraged a substantial slow-down in demand. Together, these developments left the world tanker fleet underemployed; tankers had been ordered in anticipation of higher levels of oil demand than those that materialized, and the oil that had to be moved did not have to move as far. The prices of relatively large tankers were especially hard hit by these developments, because they were not cost efficient on shorter routes. It can be seen in table 11 that the price of a 5-year-old very large crude carrier (VLCC) fell from $27.5 million in early 1980 to about $4 million in 1983. At that time, a 30,000 DWT tanker commanded a relatively higher price.

TABLE 9

PROJECTED SECONDHAND PRICES
FOR 30,000-DWT TANKER
(millions of dollars)

	Age		
Year	5 years	10 years	20 years
1987	11.0	7.0	3.0
1988	9.0	5.5	2.5
1989	8.0	4.5	2.0
1990	7.5	4.0	1.5
1991	9.0	5.0	2.0
1992	8.5	4.5	1.5
1993	12.5	7.0	3.0
1994	14.0	8.5	4.0
1995	18.0	11.0	5.5

Source: Drewry Shipping Consultants, Ltd.

TABLE 10

PROJECTED SECONDHAND PRICES
FOR 60,000-DWT TANKER
(millions of dollars)

	Age		
Year	5 years	10 years	20 years
1987	12.0	7.0	3.0
1988	11.5	6.5	2.0
1989	11.0	6.0	1.5
1990	10.0	5.0	1.5
1991	11.5	6.0	1.5
1992	14.0	7.5	3.0
1993	15.0	8.0	3.5
1994	16.0	9.5	4.0
1995	16.0	9.0	2.5

Source: Drewry Shipping Consultants, Ltd.

TABLE 11

SECONDHAND TANKER PRICES AND REPRESENTATIVE FREIGHT RATES, 1980 THROUGH 1985

		30,000 DWT			80,000 DWT			VLCC		
		Freight rate (1)	Secondhand price ($ million)		Freight rate (2)	Secondhand price ($ million)		Freight rate (3)	Secondhand price ($ million)	
			5 yrs	10 yrs		5 yrs	10 yrs		5 yrs	10 yrs
1980	1H	219	16.5	14.2	83	17.3	9.1	27	27.5	10.7
	2H	194	16.4	10.2	113	14.6	7.3	33	17.0	7.8
1981	1H	131	18.6	9.4	83	18.5	8.6	27	12.0	7.8
	2H	143	11.8	8.5	71	–	7.3	25	10.5	4.5
1982	1H	143	11.0	7.3	71	13.0	7.0	20	6.0	3.6
	2H	127	9.9	6.3	73	–	7.0	20	5.6	3.3
1983	1H	121	14.0	6.3	70	–	7.8	21	4.0	2.4
	2H	104	–	5.2	86	–	8.9	31	4.2	4.1
1984	1H	120	13.0	6.2	79	–	7.4	32	6.5[a]	6.1
	2H	104	14.0	5.0	75	–	7.5	29	10.2[a]	6.8
1985	1H	107	10.1	5.4	62	–	6.5	25	–	7.0
	2H	NA	NA	NA	NA	NA	NA	NA	NA	NA

SOURCE: Drewry Shipping Consultants, Ltd.

a. Prices for 5-year-old VLCC in 1984 are based on very limited data because of the small number of such ships in existence.

Secondhand prices for 5-year-old tankers of 30,000 DWT capacity also weakened, falling from about $16.5 million in 1980 to about $10 million in 1985. Prices rebounded in 1986 and are expected to continue doing so in 1987, in response to a declining surplus of ships. By 1988, however, the surplus of tankers is expected to increase again, as the building of new tankers outstrips the growth of tanker demand. (In the opinion of Drewry Shipping Consultants, Ltd., London, possible purchases for the RRF would not affect world tanker prices significantly unless the Navy's purchasing practices were reckless.)

On the surface, it may seem implausible that new tankers would be ordered at a time when freight rates have been relatively weak. Table 12 displays representative freight rates for a 30,000 DWT tanker; from a level of 207 in 1980, rates plummeted to 112 in 1984. Concurrently, numerous tankers were scrapped and little new building took place. In 1985 and 1986, freight rates improved, reflecting stronger oil demand resulting from falling oil prices. New tankers have been ordered not only because of the observable increases in freight rates, but also because further increases in tanker business are anticipated in the years ahead.

TABLE 12

REPRESENTATIVE FREIGHT-RATE INDEX, 30,000-DWT TANKER

Actual		Projected	
Year	Rate	Year	Rate
1980	207	1986	140
1981	137	1987	130
1982	135	1988	125
1983	113	1989	120
1984	112	1990	125
1985	120	1991	145
		1992	145
		1993	185
		1994	230
		1995	280

Falling oil prices have removed the incentive to develop new fields; it simply is not profitable to do so. The extra demand for petroleum products being stimulated by lower oil prices will be satisfied largely by increased shipments from the Middle East and North Africa to Northern Europe and the U.S. Eastern Seaboard. These "long-haul" routes generate the biggest increases in business for tanker operators; they provide a powerful incentive to bolster tanker capacity in order to capture as much of the new trade as possible. Because bigger ships are more economical for the longer routes, many of the new orders are for product tankers in the 80,000 DWT range, not in the smaller 25,000 to 40,000 DWT range that had been the most popular size for the products trades. The reason that freight rates are expected to weaken over the next 5 years, despite growing tanker demand, is that tanker operators are overreacting to both recent and anticipated improvements in the market. New building will run ahead of new demand, and freight rates and secondhand tanker prices will soften.

Starting in 1991, secondhand tanker prices are projected to rise. As shown in table 13, the supply of 30,000 DWT tankers declines, while demand posts additional modest gains. The supply of 60,000 DWT tankers rises, but at a slower rate than the anticipated growth of demand. In both size classes, the vessel surplus diminishes, leading to substantially higher secondhand prices (see table 10). There are two reasons to expect tanker supply to slow down after 1990. First, the age of the existing fleet points to accelerated scrapping. Also, the low freight rates from 1987 through 1990 lead to cutbacks in tanker construction.

TABLE 13

PROJECTED GROWTH RATES OF TANKER DEMAND AND SUPPLY
(percent)

	30,000 DWT		60,000 DWT	
	Demand	Supply	Demand	Supply
1987-90	5.9	7.2	7.8	16.3
1990-95	2.0	−1.7	5.9	4.3

PROCUREMENT COSTS

The largest cost component of the RRF is the cost of procuring ships. Projected prices of secondhand tankers on the world market are shown above in tables 9 and 10; these are prices for foreign tankers, generally powered by diesel engines. The bulk of the U.S.-flag fleet is steam powered and therefore much less economical. A diesel-powered tanker will command a premium on the secondhand market, because its anticipated net revenue stream is higher. This might seem to suggest that the Navy would do better to buy U.S.-flag secondhand tankers, because they are less expensive to purchase and their higher operating costs are unimportant because they will be inactive most of the time. However, it also was noted above that virtually all of the likely retirees from the active U.S.-flag fleet would probably be at least 20 years old by the time they were procured for the RRF. Tables 9 and 10 reveal that the prices of 20-year-old ships are expected to hover around scrap value most of the time. When ships are that old, power-plant efficiency has almost no effect on secondhand purchase price, because U.S.-flag operators can opt for scrappage at roughly $2.5 million per ship. A vessel owner may sometimes sell for less than scrap to avoid the costs of an empty voyage to a scrapyard on the other side of the world, but even then, the low prices of 20-year-old tonnage leave little room for discounting on the basis of power-plant efficiency.

A useful rule of thumb applied by tanker analysts is that old tankers will be sold for about $0.5 million over scrap value, or currently for about $3 million, in a weak market. The logic behind the formula is that owners always have the option to scrap; it sets a floor price for a secondhand sale in most circumstances. To induce an owner to sell rather than scrap, the buyer offers a small premium—perhaps an extra $0.5 million. The present and future weaknesses of the U.S. market and the age of tankers likely to drop out of commercial activity suggest that the formula is applicable to secondhand U.S.-flag tonnage.

Even so, the cost to the Navy of procuring these ships will be about $13 million. The Navy has standards for RRF vessels to assure that they will be mission-capable within 5 to 20 days. Both the Navy and the Maritime Administration (MARAD) estimate that the cost of upgrading a 20-year-old tanker to meet the procurement standards is roughly $10 million. To be sure, upgrading costs are a function of past maintenance, and some old tankers are in much better condition than others. The estimate of $10 million is an average, and it follows that on average the Navy would pay $13 million for an old U.S.-flag tanker that meets RRF specifications.

As tables 9 and 10 show, 5- and 10-year-old foreign-flag tankers are forecast to be available on the world market for less than $13 million. However, the secondhand prices in those tables are net of the costs of upgrading. For foreign-flag tonnage, upgrading costs fall into two categories: (1) the costs of meeting certain U.S. Coast Guard standards and (2) the costs associated with general deterioration. For U.S.-flag tonnage, only the latter category was applicable. For a 5-year-old, 30,000-DWT foreign-flag tanker, the estimated cost for each category is $2 million, for a total of $4 million. The anticipated upgrading costs for secondhand foreign-flag tankers of different ages and sizes are shown in table 14. A cost inflation rate of 4 percent is assumed.

TABLE 14

ESTIMATED COSTS TO UPGRADE SECONDHAND FOREIGN-FLAG TANKERS TO RRF STANDARDS
(millions of dollars)

	30,000 DWT		60,000 DWT	
	5 years old	10 years old	5 years old	10 years old
1987	4.0	6.0	4.5	7.0
1988	4.2	6.2	4.7	7.3
1989	4.3	6.5	4.9	7.6
1990	4.5	6.7	5.1	7.9
1991	4.7	7.0	5.3	8.2
1992	4.9	7.3	5.5	8.5
1993	5.1	7.6	5.7	8.9
1994	5.3	7.9	5.9	9.2
1995	5.5	8.2	6.2	9.6

Even though foreign-flag tankers must incur the additional costs of upgrading to U.S. Coast Guard standards, their total upgrading costs are lower because the ships are newer. U.S.-flag tankers in the 5- and 10-year-old categories also would have lower upgrading costs, but few such ships are projected to be available. Foreign-flag tankers in the 20-year-old category will be available, but generally would not be wanted for the RRF because they require the same expenditures to offset deterioration that 20-year-old U.S.-flag tankers do and would also have to be brought up to Coast Guard standards.

Tables 15 and 16 present projected procurement costs of RRF tankers. For foreign-flag tankers, procurement costs are the sum of the projected secondhand prices shown in tables 9 and 10 and the costs of upgrade shown in table 14. For U.S.-flag tankers, procurement costs are scrap price, plus $0.5 million, plus costs of upgrading. Procurement costs are shown only for the likely RRF candidates—old U.S.-flag tankers and newer foreign-flag tankers. The striking feature of these cost projections is that there are no bargains. It does not make a great deal of difference whether new or old ships are procured, because the selling prices are largely offset by the upgrading costs.

The procurement cost projections developed above are for two vessel sizes and three age categories. In practice, many of the tankers procured for the RRF would be other ages and other sizes. For simplicity, the assumption used

TABLE 15

FORECAST PROCUREMENT COSTS FOR 30,000-DWT RRF TANKERS
(millions of dollars)

	Foreign flag		U.S. flag
	5 years old	10 years old	20 years old
1987	15.0	13.0	13.0
1988	13.2	11.7	13.5
1989	12.3	11.0	14.1
1990	13.0	10.7	14.6
1991	13.7	12.0	15.2
1992	13.4	11.8	15.8
1993	17.6	14.6	16.4
1994	19.3	16.4	17.2
1995	23.5	19.2	19.2

TABLE 16

FORECAST PROCUREMENT COSTS FOR 60,000-DWT RRF TANKERS
(millions of dollars)

	Foreign flag		U.S. flag
	5 years old	10 years old	20 years old
1987	16.5	14.0	13.0
1988	16.2	13.8	13.5
1989	15.9	13.6	14.1
1990	15.1	12.9	14.6
1991	16.8	14.2	15.2
1992	19.5	16.0	15.8
1993	20.7	16.9	16.4
1994	21.9	18.7	17.2
1995	22.2	18.6	17.8

will be that the tankers procured from 1987 through 1992 will range from $12 to $14 million per ship, and in 1993, 1994, and 1995 the respective costs will be $17 million, $19 million, and $21 million. These values are shown in table 17.

TABLE 17

AVERAGE PROCUREMENT COSTS FOR RRF TANKERS (millions of dollars)

Time period	Cost per tanker
1987	14
1988	13
1989	12
1990	12
1991	13
1992	14
1993	17
1994	19
1995	21

The next step is to project the yearly procurement costs for the tanker portion of the RRF. In table 8, the projected tanker shortfall in 1995 is shown to be 3,400,000 DWT. However, the rate of decline of the active U.S.-flag tanker fleet is not expected to be constant over the next 9 years. Rather, about 80 percent of the tanker shortfall projected for 1995 is expected to occur by 1990 (see [1]). The assumption used in the procurement scheme is that DOD desires to fill most of the 1990 shortfall. Specifically, about 2,190,000 DWT of militarily useful tanker capacity are procured from 1987 through 1991, and about 1,050,000 DWT are procured from 1992 through 1995. The hypothetical schedule allows for the procurement of 66 tankers in the 30,000-DWT category and 21 in the 60,000-DWT category. The tanker procurement schedule and yearly RRF tanker procurement costs are shown in table 18.

TOTAL COSTS OF THE TANKER RRF

After a tanker is procured, the Navy incurs ongoing costs for general maintenance, tank maintenance, and periodic activation tests. These projected costs are displayed in table 19. Once again, a cost inflation factor of 4 percent is assumed.

TABLE 18

RRF PROCUREMENT SCHEDULE AND ANNUAL PROCUREMENT COSTS

	Yearly totals			Cumulative totals	
	Number of tankers	Tanker tonnage (DWT in thousands)	Procurement cost (millions of dollars)	Number of tankers	Tanker tonnage (DWT in thousands)
1984-86				8	146
1987	12	450	168	20	596
1988	12	420	156	32	1,016
1989	12	450	144	44	1,466
1990	12	420	144	56	1,886
1991	12	450	156	68	2,336
1992	7	270	98	75	2,606
1993	7	270	119	82	2,876
1994	7	270	133	89	3,146
1995	6	240	126	95	3,386

TABLE 19

MAINTENANCE AND ACTIVATION-TESTING COSTS OF THE RRF
(millions of dollars)

	General maintenance	Tank maintenance	Activation testing
1987	0.60	0.40	1.50
1988	0.62	0.42	1.56
1989	0.65	0.43	1.62
1990	0.67	0.45	1.69
1991	0.70	0.47	1.75
1992	0.73	0.49	1.83
1993	0.76	0.51	1.90
1994	0.79	0.53	1.98
1995	0.82	0.55	2.06

Tank maintenance is both costly and controversial. To be categorized as militarily useful, DOD requires that a ship have tanks that are 95-percent coated, preferably with epoxy. The requirement is derived from the need to transport jet fuel in support of military operations. Roughly two-thirds of the DOD fuel requirement is for jet fuel. Uncoated tanks are considered impractical because it takes too long to clean them adequately before shipment of jet fuel. Tanks previously filled with crude oil or such products as bunker fuel or regular gasoline would contaminate jet fuel unless the tanks are first cleaned adequately.

A good quality epoxy coating can cost $3 to $5 million per tanker, and the coating deteriorates over a 5-year period, especially when the tanks are empty, as they would be in the RRF. Maintaining an epoxy coating is estimated to cost at least $2 million every 5 years, or about $0.4 million per year. Fairly new tankers purchased for the RRF may have tank coatings in good condition; older ships or ships that have not been adequately maintained probably do not. Moreover, some tankers are coated with inorganic zinc rather than epoxy. Also, many coated tankers have been operating in the crude oil trades, in which they are required as a safety measure to be equipped with inert gas systems that pump engine exhaust into the tanks in order to render tank gases inert. However, the engine exhaust contains active sulfur gas that attacks the zinc coatings. For either of these reasons, tanks might need to be coated before being offered to the RRF. These initial tank-coating costs are an element of the upgrading costs that were estimated above; they are reflected in the procurement cost estimates. The annualized cost of maintaining tank coatings once a ship is in the RRF—currently about $0.4 million per year—is the tank maintenance estimate shown in table 18.

Activation tests are to be made on each RRF tanker once every 5 years. The vessel is broken out, operated, repaired as necessary, and returned to a reserve status. The cost of an activation and related repairs is estimated to be $1.5 million.

The projected yearly outlays for the RRF tanker fleet are the sum of expenditures for procurement, general maintenance, tank maintenance, and activation. The component costs and the totals are displayed in table 20. Total costs rise through 1991 before dropping off substantially in 1992. This is because tanker procurement is higher in the early years. The increases in total costs after 1992 reflect rising maintenance costs, higher procurement prices, and increased activation testing. Strictly speaking, if RRF tankers are to be tested once every 5 years, only the tankers already in the RRF fleet in 1986 would require testing prior to 1992. Some additional testing probably is desirable in the early years, however. The scheme assumes that the 8 tankers in the fleet in 1986 and the 12 procured in 1987 will be tested as follows:

Year	Number of tankers
1987	4
1988	4
1989	4
1990	4
1991	4

In addition, in 1992 the tankers tested in 1987 would be due for activation again. Starting in 1993, all tankers that were either procured or tested 5 years earlier would be due for activation.

TABLE 20

PROJECTED YEARLY OUTLAYS FOR THE RRF TANKER FLEET
(millions of dollars)

Year	Procurement	General maintenance	Tank maintenance	Activation	Total
1987	168	12.0	8.0	6.0	194.0
1988	156	19.8	13.4	6.2	195.4
1989	144	28.6	18.9	6.5	198.0
1990	144	37.5	25.2	6.8	213.5
1991	156	47.6	32.0	7.0	242.6
1992	98	54.8	36.8	7.3	196.9
1993	119	62.3	41.8	30.4	253.5
1994	133	70.3	47.1	31.7	282.1
1995	126	77.9	52.3	33.0	289.2

RRF COSTS VERSUS RRF BUDGETS

The RRF budget has not escaped the Gramm-Rudman deficit-reduction process. Actual appropriations for procurement, upgrading, maintenance, and activation testing are $152.1 million for FY 1987, down from $288 million in FY 1986. Estimated funding for the total RRF over the next 5 years is shown in table 21, along with the estimates of required funding for the tanker RRF that were developed in the previous section. The estimated budget for the total RRF is the sum of the projected appropriations for the SCN (shipbuilding and conversion) and M&R (maintenance and repair) accounts for the 1988-1992 Five-Year Defense Plan (FYDP). The FY 1988 through FY 1989 estimates have already undergone program reviews, but the appropriations process still lies ahead and undoubtedly will result in numerous changes. The FY 1990 through FY 1992 estimates are DOD's outyear projections. The striking feature of table 21 is that the CNA estimates of necessary funding for the reserve tanker fleet are substantially higher than the likely funding for the total RRF – that is, dry cargo programs as well as tanker programs.

TABLE 21

THE RRF BUDGET AND TANKER FUNDING REQUIREMENTS
(millions of dollars)

	Total RRF	Tanker RRF
	Current budget estimates	Required funding
1987	152.1	194.0
1988	127.4	195.4
1989	117.7	198.0
1990	150.4	213.5
1991	107.6	242.6
1992	143.4	196.9

The size of the shortfall in funding for the tanker RRF cannot be uniquely determined because the RRF appropriations are not earmarked for either dry-cargo or tanker programs. For instance, in the current fiscal year (FY 1987) the Navy can use its SCN appropriation for the RRF ($78 million) to purchase only tankers, only dry-cargo ships, or varying percentages of both. What it cannot do is use SCN funds for M&R or vice versa. Thus, in order to project the shortfall in tanker funding, the allocation of funds to dry-cargo and to tanker procurements first must be projected. These estimates are shown in tables 22 and 23. OP-42 currently anticipates building the RRF tanker fleet to 20 handy-sized ships by 1992. The Navy recognizes the need for a larger reserve tanker fleet: 46 were recommended when the Office of the Secretary of Defense (OSD) last analyzed the problem [2]. However, the Navy also recognizes that the funds will not be there, given the need for spending on the dry-cargo RRF as well.

TABLE 22

TANKER PROCUREMENT FOR THE RRF: CURRENT NAVY EXPECTATIONS

	Number of tankers		Millions of dollars		
	Tanker additions	Cumulative RRF tanker fleet	Procurement cost	General maintenance	Total outlays
1987	4	12	56	7.2	63.2
1988	0	12	0	7.4	7.4
1989	2	14	24	9.1	33.1
1990	1	15	12	10.1	22.1
1991	1	16	13	11.2	24.2
1992	4	20	56	14.6	70.6

TABLE 23

THE RRF BUDGET: ESTIMATED DRY-CARGO AND TANKER PROGRAM OUTLAYS (millions of dollars)

	Dry cargo	Tanker
1987	88.9	63.2
1988	120.0	7.4
1989	84.6	33.1
1990	128.3	22.1
1991	83.4	24.2
1992	72.8	70.6

Currently there are 8 tankers in the RRF. Three of them are small T1 tankers, of limited use for general strategic lift. They are assigned to intratheater movements such as the relocation of prepositioned fuels. OP-42 expects to procure 12 more tankers during 1987 through 1992, as shown in table 22. In doing so, OP-42 is allowing only for the costs of procurement and general maintenance. Thus, only the minimum costs necessary to bring tankers into the reserve fleet are allowed for in this plan; little or no funds are allocated for special tank maintenance or for activation testing, because such items appear to be unaffordable luxuries. The estimates of dry-cargo spending in table 23 are derived as a residual, by subtracting projected tanker spending from the total RRF budget estimates shown in table 21. No attempt is made in this study to assess whether dry-cargo spending is sufficient to accomplish the mission.

On the basis of the projected allocation of funds between tanker and dry-cargo programs, it is possible to estimate the yearly shortfalls between required spending for tanker programs and projections of actual Navy expenditures. The shortfalls are listed in table 24. The required outlays are those estimated in this study and reported in tables 20 and 21. Projections of actual spending are taken from table 23.

TABLE 24

THE SPENDING SHORTFALL FOR THE TANKER RRF (millions of dollars)

	Required spending	Projected actual spending	Shortfall
1987	194.0	63.2	130.8
1988	195.4	7.4	188.4
1989	198.0	33.1	167.9
1990	213.5	22.1	191.4
1991	242.6	24.2	218.4
1992	196.9	70.6	126.3

The shortfalls shown in table 24 are probably understated. They are derived by assuming that the Navy actually procures 12 more tankers at secondhand prices in the $12 million to $14 million range. The Navy may not do so, because the plan to acquire 12 more tankers was developed under the expectation that secondhand tankers could be procured for about $6 million each in the years ahead, or roughly half of what used tankers are likely to command. At the same time that current and anticipated secondhand tanker prices have been rising, annual RRF budgets in recent five-year defense plans have been falling. Even when a $6-million used tanker was a reality and the budget outlook was brighter, OP-42 was holding additional tanker procurement down to 12, because buying tankers meant foregoing dry-cargo program elements. Now the "opportunity cost" of tankers is considerably higher, and the result may well be a tanker RRF target of less than 20. In light of these rising prices, OP-42 is presently considering whether to procure tankers this year and, if so, how many. To the extent that tanker spending is more constrained than that shown in tables 23 and 24, the tanker shortfalls will be larger.

Moreover, in order to build the tanker RRF to the size required to accomplish the sealift mission, additional tanker procurements are required in 1993 through 1995, as discussed in the previous section. Required yearly outlays for the RRF tanker fleet are about $250 million to $290 million annually during 1993 through 1995, higher than in earlier years (see table 20). Tanker spending shortfalls cannot be estimated for these later years because the RRF budget is not presently projected beyond 1992. In all likelihood, however, the shortfalls in 1993 through 1995 would be above those shown for earlier years. The spending shortfall in 1992 is an anomaly, brought about because the Navy currently plans to procure 4 tankers in that year, and only one in each of the previous 2 years. It is not the start of a downward trend in the spending shortfall.

Fiscal stringency might result not only in an RRF of inadequate size to perform the mission, but also in a force that will not be ready to do so. Even if the Navy were to obtain sufficient SCN funds to build the tanker RRF to the 95 ships recommended in this study and to realize the dry-cargo ship target of 100, it also would be necessary to increase M&R funding substantially. Such an increase is improbable, given the well-known tendency of budget cutters to focus on M&R.

The M&R budget for FY 1987 and for the FY 1988-1992 Five-Year Defense Plan is shown in the first column of table 25. The estimates of general maintenance are made under the assumption that the RRF is indeed increased to 195 ships. The dry-cargo target is reached in 1992, in accordance with current Navy planning. The tanker target is reached 1995, in accordance with the schedule developed above in table 18. General maintenance is the rock-bottom level for M&R; it provides for no special tank maintenance and for no activation testing and related repairs for either tankers or dry cargo ships. Nonetheless, the M&R budget comes up short starting in 1989. In table 26, tank maintenance is included in the requirement, and shortfalls triple in the early 1990s.

TABLE 25

ROCK-BOTTOM MAINTENANCE FOR THE TOTAL RRF
(millions of dollars)

		General maintenance requirement		
	M&R budget	Total	Tanker	Dry cargo
1987	74.3	60.6	12.0	48.6
1988	84.0	74.4	19.8	54.6
1989	82.3	89.7	28.6	61.1
1990	87.6	102.5	37.5	65.0
1991	93.8	117.6	47.6	70.0
1992	106.5	127.8	54.8	73.0

TABLE 26

THE M&R SHORTFALL, INCLUDING TANK MAINTENANCE
(millions of dollars)

		Maintenance requirement		
	M&R budget	Total	Tank maintenance	General maintenance
1987	74.3	68.6	8.0	60.6
1988	84.0	87.8	13.4	74.4
1989	82.3	108.6	18.9	89.7
1990	87.6	127.7	25.2	102.5
1991	93.8	149.6	32.0	117.6
1992	106.5	164.6	36.8	127.8

If the activation-testing standard for the RRF is upheld, the M&R shortfalls are much larger. In table 27, the required outlays for testing ships every fifth year are shown under "steady state" circumstances—after the RRF has attained its 195 ship target. In the year 2000, about $97.5 million would be required for activation tests. Deflating to 1987 dollars, the cost would be about $58.5 million annually. (An annual inflation rate of 4 percent is assumed.)

TABLE 27

REQUIRED OUTLAYS FOR ACTIVATION TESTING FOR 195 SHIP RRF
(millions of dollars)

Current dollars in the year 2000	
Dry cargo ships	50.0
Tankers	47.5
Total	97.5
Constant 1987 dollars	
Dry cargo ships	30.0
Tankers	28.5
	58.5

In summary, as demonstrated in this section, in 1988 the shortfall in total tanker spending (SCN plus M&R) for the RRF is expected to be about $190 million, and shortfalls are likely to rise to $220 million or more during most of the early to mid-1990s. The shortfalls will be larger still if the Navy chooses to cut its RRF tanker procurement target below 20. Should the Navy succeed in obtaining the additional funds to procure 195 ships for the RRF, the M&R budget in the current five-year defense plan would be seriously inadequate. It would not allow the general maintenance, tank maintenance, testing, and repair that are considered necessary to assure readiness.

ALTERNATIVE ESTIMATES

Estimates of the specific RRF cost components and of total RRF costs are best viewed as ballpark figures. Costs of upgrading, general maintenance, and tank maintenance are based on a range of opinion of tanker experts at major oil companies, the Maritime Administration (MARAD), the Military Sealift Command (MSC), and the Navy. The respondents emphasized that these costs can vary substantially from tanker to tanker, and thus depend on the specific vessels that are procured. Also, experience with a fleet such as the RRF is limited. The National Defense Reserve Fleet (NDRF) does not provide much relevant experience because its vessels are not maintained in a high state of readiness.

Secondhand tanker prices were forecast through 1995 by Drewry Shipping Consultants, London — widely acknowledged to be the best source available. Nonetheless, these forecasts must rely on the worldwide outlook for crude oil and refined petroleum production, demand, and distribution, and even the best analyses of those markets over a 9-year forecast horizon are subject to some risks. For that reason, an alternative estimate of the costs of the tanker RRF is presented. The most controversial cost item is tank coating, as indicated above. This expense has a large impact on costs of both upgrading and maintenance.

Some tanker analysts argue that tank-coating costs are not necessary. The alternative is to blast the tank coatings on RRF ships to bare steel and then dehydrate the tanks. Periodically, some scaling might have to be removed, but this is thought to be a minor problem. As mentioned earlier, good tank coatings are desirable because they make cleaning tanks easier when they have been used to carry a product such as motor gasoline or even crude oil and are needed to carry the more sensitive jet fuel. In wartime, roughly two-thirds of the fuel-transportation requirement is for jet fuel. Thus, the argument goes, most tankers could carry the same product continuously, largely eliminating the need for tank cleaning. Under such circumstances, bare metal tanks would suffice. What most needs to be avoided are deteriorated tank coatings, which have bubbles and blisters. Products carried in the tank get stuck in the pockets and can contaminate a cargo of jet fuel. Blasting solves the problem of deteriorated coatings.

The Defense Fuel Supply Center (DFSC) makes determinations on the acceptability of fuel-delivery methods. DFSC's current position is that bare metal tanks are sufficient for carrying jet fuel if they are clean and dry before loading and have been cleaned thoroughly before carrying jet fuel if they have carried other fuels. It is noteworthy that fleet oilers have uncoated tanks, because tanks are segregated and a given tank always carries the same product. As a further precaution, fuel is filtered as it is pumped from oilers. A problem with using bare metal tanks in a wartime-planning scenario is that it further constrains the use of individual tankers. Epoxy- coated tanks provide schedulers more degrees of freedom in using a given fleet to deliver different fuels to many locations.

If further analysis and experimentation indicate that bare metal tanks are a workable option, procurement costs and total outlays for the tanker RRF would approximate those shown in table 28. Required yearly outlays would be lower by roughly $60 million in the early 1990s, and the yearly shortfalls between budgeted spending for the tanker RRF and required spending would decline comparably. This is an option worth pursuing if, indeed, the Navy chooses to continue relying on the RRF to fill the tanker shortfall. Even given this optimistic alternative projection, however, the required tanker spending exceeds anticipated funding by $130 to $155 million per year from 1988 through 1991, and by larger amounts in 1993 through 1995. Thus, it appears that the RRF would remain substantially underfunded.

TABLE 28

ALTERNATIVE PROJECTION OF REQUIRED SPENDING FOR THE RRF TANKER FLEET
(millions of dollars)

	Yearly outlays	Spending shortfall
1987	159.0	95.8
1988	153.8	146.4
1989	150.0	116.9
1990	157.7	135.6
1991	178.8	154.6
1992	139.7	69.1
1993	190.5	n.a.
1994	213.1	n.a.
1995	218.1	n.a.

The yearly outlays in table 28 were estimated under the assumption that the tanks of half of the tankers procured for the RRF each year would need a thorough recoating at about $3 million per application (in 1987 dollars). The other half would need a lesser tank upgrading, at an average cost of about $1.5 million. These assumptions reflect the observation of experienced players in tanker markets that maintenance usually is deferred on ships that are not profitable. These, of course, are the very ships that most often end up on

APPENDIX

PROJECTION OF ACTIVE AND RETIRED TANKERS, 1986 THROUGH 1995

APPENDIX

PROJECTION OF ACTIVE AND RETIRED TANKERS, 1986 THROUGH 1995

- Tankers retiring from U.S.-flag fleet: 1986 through 1995 (table A-1).
- Tankers operating in Alaskan North Slope Trade in 1995 (table A-2).
- Tankers operating in Gulf-to-East Coast trade in 1995 (table A-3).
- Tankers operating on the East Coast in 1995 (table A-4).
- Tankers operating on the West Coast in 1995 (table A-5).
- CDS tankers in 1995 (table A-6).
- MSC tankers in 1995 (table A-7).

Tankers were assigned to trade routes where they are most likely to be profitable on the basis of tanker size, age, tank coating, and past operating experience. It must be emphasized that in many cases a tanker allocated to one route might well operate on another. Also, tankers can be bought and sold, and the disposition of a given vessel will depend on the trading opportunities and financial condition of a particular owner. In this sense the tanker listings are merely illustrative. The overall picture, not the assignment of an individual ship, is what matters.

NOTE: The following abbreviations are used in the appendix tables: YEAR, year built; CDS, Construction Differential Subsidy; MIL USE, military use. Abbreviations for tank coatings are: PCIZ, partial coating inorganic zinc; CE, coating epoxy; CIZ, coating inorganic zinc; NC, no coating; CEIZ, coating epoxy inorganic zinc.

TABLE A-1 (Continued)

SHIP NAME	SHIP TYPE	DWT	YEAR	CDS	TANK COATING	ENGINE	MIL USE
STUYVESANT	PRODUCT TANKER	224670	77	Y	CIZ	STEAM	N
CHEVRON LOUISIANA	CRUDE TANKER	039258	77	N	NC	STEAM	N
COURIER	PRODUCT TANKER	035100	77	Y	CIZ	DIESEL	Y
OVERSEAS WASHINGTON	PRODUCT TANKER	090515	78	Y	CE	STEAM	Y
TONSINA	CRUDE TANKER	122781	78	N	NC	STEAM	N
EXXON BENICIA	CRUDE TANKER	172775	79	N	NC	STEAM	N
U S T ATLANTIC	PRODUCT TANKER	398143	79	Y	CIZ	STEAM	N
KENAI	CRUDE TANKER	123113	79	N	NC	STEAM	N
U S T PACIFIC	PRODUCT TANKER	398143	79	Y	CIZ	STEAM	N

TABLE A-2

TANKERS OPERATING IN ALASKAN NORTH SLOPE TRADE IN 1995

SHIP NAME	SHIP TYPE	DWT	YEAR	CDS	TANK COATING	ENGINE	MIL USE
OVERSEAS BOSTON	CRUDE TANKER	121739	74	N	NC	DIESEL	N
PRINCE WILLIAM SOUND	CRUDE TANKER	123995	75	N	NC	STEAM	N
ARCO SPIRIT	PRODUCT TANKER	262376	77	Y	PCE	STEAM	N
ARCO INDEPENDENCE	PRODUCT TANKER	262376	77	Y	PCE	STEAM	N
OVERSEAS OHIO	PRODUCT TANKER	090564	77	N	CE	STEAM	Y
ATIGUN PASS	CRUDE TANKER	173380	77	N	NC	STEAM	N
OVERSEAS CHICAGO	PRODUCT TANKER	090637	77	N	CE	STEAM	Y
OVERSEAS NEW YORK	PRODUCT TANKER	090393	77	N	CE	STEAM	Y
B T ALASKA	CRUDE TANKER	182204	78	N	NC	STEAM	N
THOMPSON PASS	CRUDE TANKER	173619	78	N	CIZ	STEAM	N
KEYSTONE CANYON	CRUDE TANKER	173380	78	N	NC	STEAM	N
B T SAN DIEGO	CRUDE TANKER	182204	78	N	NC	STEAM	N
BROOKS RANGE	CRUDE TANKER	173619	78	N	CIZ	STEAM	N
EXXON NORTH SLOPE	CRUDE TANKER	172537	79	N	NC	STEAM	N
ARCO ALASKA	CRUDE TANKER	188436	79	N	PCE	STEAM	N
BAY RIDGE	PRODUCT TANKER	224428	79	N	CIZ	STEAM	Y
ARCO CALIFORNIA	CRUDE TANKER	188697	80	N	CE	STEAM	N
EXXON NEW BUILD	PRODUCT TANKER	210000	86	N	NC	DIESEL	N
EXXON NEW BUILD	PRODUCT TANKER	210000	86	N	NC	DIESEL	N

TABLE A-3

TANKERS OPERATING IN GULF-TO EAST COAST TRADE IN 1995

SHIP NAME	SHIP TYPE	DWT	YEAR	CDS	TANK COATING	ENGINE	MIL USE
FALCON DUCHESS	PRODUCT TANKER	037276	71	N	CE	DIESEL	Y
FALCON PRINCESS	PRODUCT TANKER	037276	72	N	CE	DIESEL	Y
OMI HUDSON	PRODUCT TANKER	050852	81	N	CEIZ	DIESEL	Y
JULIUS HAMMER/OXY 4101	LIQUID ITB	045313	81	Y	CE	DIESEL	Y
BLUE RIDGE	PRODUCT TANKER	037500	81	N	CE	STEAM	Y
CHESAPEAKE TRADER	PRODUCT TANKER	050116	82	N	CE	DIESEL	Y
EXXON PRINCETON	PRODUCT TANKER	042934	82	N	CE	DIESEL	Y
JACKSONVILLE/JACKSONVILL	LIQUID ITB	047247	82	N	CIZ	DIESEL	Y
GROTON/GROTON	LIQUID ITB	047247	82	N	CIZ	DIESEL	Y
EXXON YORKTOWN	PRODUCT TANKER	042650	83	N	CE	DIESEL	Y
EXXON CHARLESTON	PRODUCT TANKER	042000	83	N	CE	DIESEL	Y
NEW YORK/NEW YORK	LIQUID ITB	047247	83	N	CIZ	DIESEL	Y
PHILADELPHIA/PHILADELPHI	LIQUID ITB	047247	84	N	CIZ	STEAM	Y
MOBILE/MOBILE	LIQUID ITB	047247	84	N	CIZ	DIESEL	Y
EXXON WILMINGTON	PRODUCT TANKER	048011	84	N	CE	DIESEL	Y
EXXON BAYTOWN	CRUDE TANKER	057720	84	N	NC	DIESEL	N

TABLE A-4

TANKERS OPERATING ON THE EAST COAST IN 1995

SHIP NAME	SHIP TYPE	DWT	YEAR	CDS	TANK COATING	ENGINE	MIL USE
FRANCES HAMMER/OXY4103	LIQUID ITB	045313	81	Y	C	DIESEL	Y
OXY PRODUCER	LIQUID ITB	037054	81	Y	CIZ	STEAM	Y
ENERGY ALTAIR/ENERGY AMM	LIQUID ITB	016000	82	N	C	DIESEL	N
BALTIMORE/BALTIMORE	LIQUID ITB	047247	83	N	CIZ	DIESEL	Y
POTOMAC TRADER	PRODUCT TANKER	050057	83	N	CE	DIESEL	Y

TABLE A-5

TANKERS OPERATING ON THE WEST COAST IN 1995

SHIP NAME	SHIP TYPE	DWT	YEAR	CDS	TANK COATING	ENGINE	MIL USE
GOLDEN GATE	PRODUCT TANKER	062115	70	N	CE	STEAM	Y
SANSINENA II	PRODUCT TANKER	070459	71	N	CIZ	STEAM	Y
ARCO SAG RIVER	PRODUCT TANKER	070215	72	N	CEIZ	STEAM	Y
CHEVRON CALIFORNIA	PRODUCT TANKER	070213	72	N	CEIZ	STEAM	Y
CHEVRON OREGON	CRUDE TANKER	039274	75	N	NC	STEAM	N
CHEVRON COLORADO	PRODUCT TANKER	039304	76	N	CEIZ	STEAM	Y
CHEVRON WASHINGTON	PRODUCT TANKER	039364	76	N	CEIZ	STEAM	Y
CHEVRON ARIZONA	PRODUCT TANKER	039298	77	N	CEIZ	STEAM	Y
NEW YORK SUN	PRODUCT TANKER	034400	80	N	CE	DIESEL	Y
SIERRA MADRE	PRODUCT TANKER	036756	81	N	CE	STEAM	Y
PHILADELPHIA SUN	PRODUCT TANKER	034090	81	N	CE	DIESEL	Y
COAST RANGE	PRODUCT TANKER	036756	81	N	CE	STEAM	Y
DELEWARE TRADER	PRODUCT TANKER	050057	82	N	CE	DIESEL	Y

TABLE A-6

CDS TANKERS IN 1995

SHIP NAME	SHIP TYPE	DWT	YEAR	CDS	TANK COATING	ENGINE	MIL USE
GOLDEN ENDEAVOR	PRODUCT TANKER	081849	74	Y	CIZ	STEAM	Y
CHESTNUT HILL	PRODUCT TANKER	091295	76	Y	CE	STEAM	Y
BEAVER STATE	PRODUCT TANKER	091849	76	Y	CIZ	STEAM	Y
MORMACSUN	PRODUCT TANKER	039232	76	Y	CE	STEAM	Y
PATRIOT	PRODUCT TANKER	035100	76	Y	CE	DIESEL	Y
AMERICAN HERITAGE	PRODUCT TANKER	091849	76	Y	CIZ	STEAM	N
MORMACSKY	PRODUCT TANKER	039232	77	Y	CE	STEAM	Y
KITTANNING	PRODUCT TANKER	091344	77	Y	CE	STEAM	Y

TABLE A-7

MSC TANKERS IN 1995

SHIP NAME	SHIP TYPE	DWT	YEAR	CDS	TANK COATING	ENGINE	MIL USE
OVERSEAS VALDEZ	PRODUCT TANKER	037814	68	N	CE	STEAM	Y
OVERSEAS ALICE	PRODUCT TANKER	037814	68	N	CE	STEAM	Y
OVERSEAS VIVIAN	PRODUCT TANKER	037814	69	N	CE	STEAM	Y
SEALIFT PACIFIC	PRODUCT TANKER	027298	74	N	CE	DIESEL	Y
SEALIFT MEDITERRANEAN	PRODUCT TANKER	027217	74	N	CE	DIESEL	Y
SEALIFT ATLANTIC	PRODUCT TANKER	027214	74	N	CE	DIESEL	Y
SEALIFT INDIAN OCEAN	PRODUCT TANKER	027298	75	N	CE	DIESEL	Y
SEALIFT CHINA SEA	PRODUCT TANKER	027298	75	N	CE	DIESEL	Y
SEALIFT CARIBBEAN SEA	PRODUCT TANKER	027223	75	N	CE	DIESEL	Y
SEALIFT ANTARTIC	PRODUCT TANKER	027200	75	N	CE	DIESEL	Y
SEALIFT ARCTIC	PRODUCT TANKER	027223	75	N	CE	DIESEL	Y
SEALIFT ARABIAN SEA	PRODUCT TANKER	027298	75	N	CE	DIESEL	Y
ROVER	PRODUCT TANKER	035100	77	Y	CE	DIESEL	Y
FALCON LEADER	PRODUCT TANKER	033334	83	Y	CE	DIESEL	Y
FALCON CHAMPION	PRODUCT TANKER	033542	84	Y	CE	DIESEL	Y
PAUL BUCK	PRODUCT TANKER	029500	85	N	CE	STEAM	Y
GUS W. DARNELL	PRODUCT TANKER	028600	85	N	CE	STEAM	Y
SAMUEL COBB	PRODUCT TANKER	028600	86	N	CE	STEAM	Y
RICHARD G MATHSEN	PRODUCT TANKER	028600	86	N	CE	STEAM	Y